

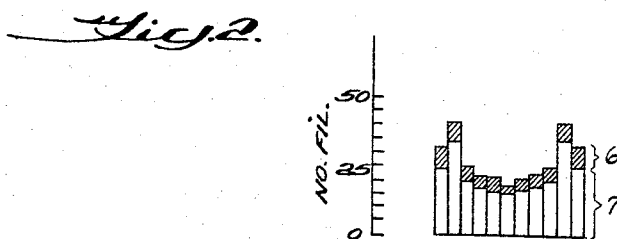
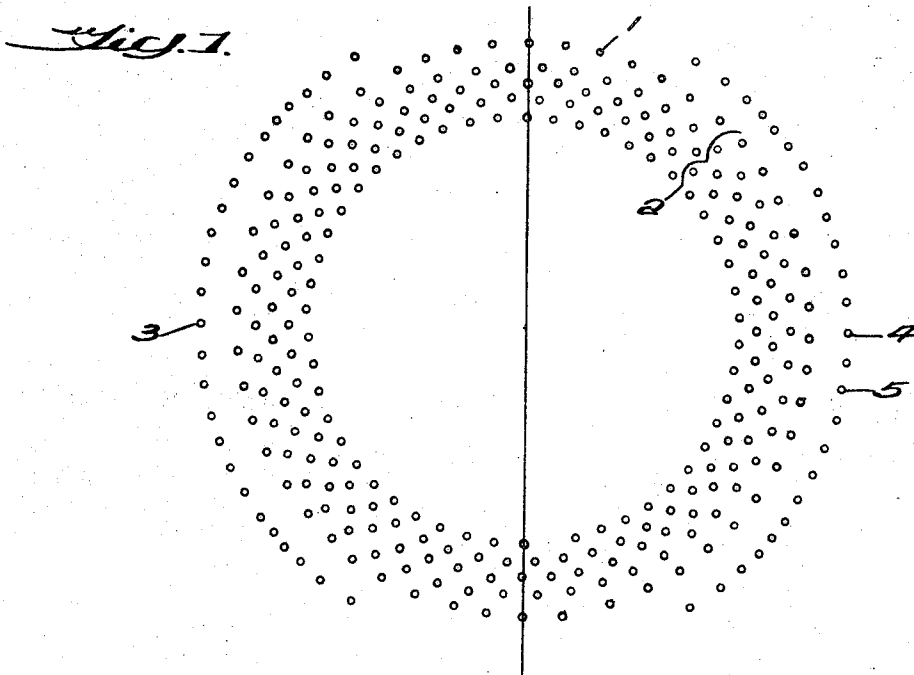
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METHOD AND APPARATUS FOR FORMING NONWOVEN SHEETS

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ABSTRACT OF THE DISCLOSURE

A spinneret plate having one group of apertures arranged in concentric circles and a second group of apertures arranged in arcs surrounding and concentric with the first group. A projection of all apertures on a plane perpendicular to and bisecting the plane of the spinneret plate between the arcs contains a substantially constant ratio of the two groups.

This invention relates to method and apparatus for spinning molten, organic filament-forming compositions and more particularly to a spinneret design therefor.

It has been customary in the melt-spinning of organic polymeric materials to use spinnerets with a circular aperture-pattern to produce round strands of filaments. The circular pattern is a preferred design because it can be used with radial quenching which provides uniform cooling with good filament stability in the quench chimney. The round strands produced with circular-aperture-pattern spinnerets are very suitable for conversion to continuous filament yarns, or by blending with additional similar strands, for formation of thick tows for subsequent crimping and other operations. Circular-aperture-pattern spinnerets may also be conveniently used when it is desired to spin filaments of different composition from the same spinneret. Simple polymer distribution means known in the art allow spinning of different compositions from concentric rings of spinneret orifices.

In accordance with the present invention a multifilament strand is spun having the filaments therein so disposed as to be eminently suitable for the economical commercial manufacture of nonwoven webs using the recently-developed web-laydown process described in British Patent 932,482. In this process, which utilizes an integrated filament-spinning, attenuation and web-laydown operation, a multifilament strand of freshly spun, continuous filaments is electrostatically charged under tension, for example, by passing the filaments through a corona discharge zone; the charged filaments are then forwarded by means of a jet device towards a web-laydown zone; the tension on the filaments is released as they exit the jet device, thereby permitting them to separate due to the applied electrostatic charge; and the filaments, while thus separated, are collected as a nonwoven web.

In the step of application of an electrostatic charge to filaments by triboelectric charging or by the corona discharge technique described in DiSabato and Owens, U.S. Patent 3,163,753, the filament strands are contacted with cylindrical target bars. The corona discharge technique is a preferred method because it permits the application of a uniform, high level of charge to each of the multifilament strands.

In order to prepare wide webs economically by the aforementioned integrated process, it is necessary to use the output from a plurality of spinnerets. This in turn makes it necessary to use mechanical attenuation of the filaments, for example, with draw rolls, in order to obtain uniform filament properties from each of the spinnerets and, therefore, uniform properties throughout the

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nonwoven web. When such draw rolls are used, the bundle of filaments is flattened into a ribbon which may conveniently be forwarded with a slot-jet device toward a web-laydown belt.

In the production of nonwoven webs by the above-described integrated process, it has now been found that the filaments must be spaced from one another in the strand in a designated relationship in order to obtain uniform webs which are free from aggregates or bundles of filaments. While this distribution is very important in the matrix filament strands which make up the predominant or entire filamentary structure of the nonwoven web, it is particularly required when binder filaments are spun with the matrix filaments from the same spinneret. This method for distributing the binder throughout the nonwoven web requires a blending of the binder filaments with the matrix filaments which will produce a uniform blend of the two types of fiber at the laydown belt. Strands issuing from spinnerets with circular aperture-patterns in which a ring of binder filament apertures has been spaced around the circularly disposed matrix filament apertures have been found to result in webs of less than the desired uniformity when the above-described integrated process is employed.

It is a purpose of this invention to provide a spinneret design for the production of a multifilament strand containing both binder and matrix filaments which can be converted into uniform nonwoven webs.

This and other purposes are attained by providing a spinneret suitable for the spinning of two types of filaments from the same spinneret comprising a first group of apertures for spinning one type of filament arranged uniformly in concentric circles and a second group of apertures for spinning a second type of filament arranged in arcs surrounding and concentric with the circles of the first group of apertures and arranged so that a projection of all apertures in both groups on a plane perpendicular to and bisecting the plane of the spinneret face between the arcs contains a substantially uniform ratio of the two types of filament.

The spinneret design of this invention permits ready quenching of the filaments by directing the gaseous cooling medium (for example, air) either in the same direction as the arcs or perpendicular to them. The latter method is particularly effective because the cooling medium has ready access to all the filaments. The spinneret design is also particularly well adapted to radial quenching which provides uniform, effective cooling with good filament stability in the quench chimney.

Preferably, the apertures for the matrix filaments are arranged in concentric circles, with each circle having uniform circumferential spacing between each aperture, and the apertures for the binder filaments are arranged in two, equal-length, diametrically-opposed arcs. The length of the arcs are such that lines drawn from the ends of one arc to the corresponding opposed ends of the other arc are approximately tangent to the outermost circle of the matrix apertures.

The size of the apertures is not critical. Typical sizes for the binder and matrix apertures are about 6 to 15 mils and 6 to 40 mils, respectively. The shape of the apertures may take any of several configurations, such as trilobal, round, square, elliptical, ribbon, etc.

FIGURE 1 is a plan view, on an enlarged scale, of a specific embodiment of the spinnerets of this invention. FIGURE 1 shows a spinneret with apertures 1 arranged on five concentric circles 2 of 50 apertures each for spinning matrix filaments and two arcs 3 and 4 each containing 25 apertures 5 for spinning binder filaments. A projection of all apertures in both groups on a plane perpendicular to and bisecting the plane of the spinneret face at a point equal distant from the ends of the two arcs,

provides a substantially uniform distribution of the binder filaments throughout the matrix filaments. During use in the web-laydown process described above, each spinneret is positioned with the above plane parallel to the axes of the rotating guide members which convert the strand of filaments to a flat ribbon, thus the above plane is parallel to the plane of the ribbon of filaments.

FIGURE 2 is a graphical representation of a projection of the distribution of binder and matrix filaments from the spinneret illustrated in FIGURE 1 in a plane bisecting the space between the arcs containing the binder filament apertures. It can be seen that more binder 6 and matrix 7 filaments are present at the edge of the resulting ribbon of filaments than in the center. Projection of such a ribbon onto a moving belt would be expected to give a swath with heavy edges. FIGURE 3 is a graphical representation of a typical distribution of filaments 6 and 7 across the width of a 25 inch swath collected on a moving laydown belt using the hereinbefore described integrated process including the spinneret of FIGURE 1. The weight of filaments across the width of the swath is substantially uniform except for the edges which are tapered uniformly. Swaths with tapered edges are especially suitable for blending with similar swaths to form a wide width web of substantially uniform basis weight.

A nonwoven web is produced by the above-described, integrated web-laydown process using a series of spinnerets with a grouping of five concentric circular aperture patterns containing a total of 250 apertures to spin matrix filaments of poly(ethylene terephthalate) and two arcs of 25 apertures each arranged as in FIGURE 1, to spin binder filaments of a 79/21 copolymer of poly(ethylene terephthalate)/poly(ethylene isophthalate). The outputs from the spinnerets are converted to individual ribbons of filaments by contact with appropriate guide surfaces and draw rolls. Each ribbon of filaments contains uniformly spaced binder filaments dispersed in the matrix filaments. The ribbons are electrostatically charged by corona discharge devices positioned between the spinnerets and draw rolls. A ribbon of uniformly blended filaments is then directed toward the web-laydown zone by filament-forwarding slot jet devices. The jet devices are positioned to give 67% overlap between the laterally-adjacent areas of deposition of the filaments on a moving web-laydown receiver. Suction is applied beneath the receiver in the web-laydown zone to pin the filaments to the receiver and to counteract the aerodynamic and electrostatic interference between the outputs from adjacent jets. The binder distribution across the nonwoven web is found to be uniform. A significantly better binder distribution is obtained with the spinneret of this invention than with previously known

methods of blending binder and matrix filaments such as circular-binder-aperture design, especially at the edges of the web.

What is claimed is:

1. A spinneret plate having a first group of apertures arranged uniformly in concentric circles and a second group of apertures arranged in arcs surrounding and concentric with the circles of said first group of apertures such that a projection of all apertures of both groups on a plane perpendicular to and bisecting the plane of said spinneret plate between the arcs contains a substantially constant ratio of the two groups of apertures.

2. A spinneret plate having a first group of apertures arranged in concentric circles, each circle having uniform circumferential spacing between apertures, and having a second group of apertures arranged in two opposed arcs surrounding and concentric with the circles of said first group of apertures such that a projection of all apertures of both groups on a plane perpendicular to and bisecting the plane of said spinneret plate between the arcs contains a substantially constant ratio of the two groups of apertures.

3. Claim 2 wherein the first group of apertures are arranged in 5 circles of 50 apertures each and the second group of apertures are arranged in 2 arcs of 25 apertures each.

4. In a method for making nonwoven sheets wherein organic polymeric materials are melt-spun into a plurality of filaments, the filaments are attenuated with draw rolls, electrostatically charged under tension and forwarded by means of a jet device towards a web-laydown zone while the tension is relaxed, the improvement comprising extruding through a spinneret plate one group of filaments uniformly in concentric circles and a second group of filaments in arcs surrounding and concentric with the circles of said first group of filaments such that a projection of all filaments on a plane perpendicular to and bisecting the plane of said spinneret plate between the arcs contains a substantially constant ratio of the two groups of filaments.

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